The youngest get the pill: ADHD misdiagnosis in Germany, its regional correlates and international comparison

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Abstract: Attention Deficit/Hyperactivity Disorder (ADHD) is a leading diagnosed health condition among children in many developed countries but the causes underlying these high levels of ADHD remain highly controversial. Recent research for the U.S., Canada and some European countries shows that children who enter school relatively young have higher ADHD rates than their older peers, suggesting that ADHD may be misdiagnosed in the younger children due to their relative immaturity. Using rich administrative health insurance claims data from Germany we study the effects of relative school entry age on ADHD risk in Europe's largest country and relate the effects for Germany to the international evidence. We further analyze different mechanisms that may drive these effects, focusing on physician supply side and demand side factors stemming from the production of education. We find robust evidence for school-entry age related misdiagnosis of ADHD in Germany. Within Germany and internationally, a higher share of misdiagnoses are related to a higher overall ADHD level, suggesting that misdiagnoses may be a driving factor of high ADHD levels. Furthermore, the effects in Germany seem to be driven by teachers and parents in an attempt to facilitate and improve the production of education.

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Supplementary Online Appendix
to the paper

The Youngest Get the Pill: ADHD Misdiagnosis in Germany, Its Regional Correlates and International Comparison.

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A. Comparison of ADHD Prevalence Rates across Data Sources

A study published in 2013 by one of the largest health insurance plans in the German Social Health Insurance (SHI), Barmer GEK, presents ADHD diagnosis prevalence rates for children aged 5-9 and 10-14 in the years 2008 through 2011. The data contain information on all children insured with Barmer GEK, irrespective of their health care use in the given year. The results presented in the study rely on only one valid diagnosis to calculate ADHD diagnosis prevalence. To compare ADHD prevalence in our data to the published results, Figure A1 displays diagnoses prevalence based on one diagnosis in our data in addition to the baseline measures using two diagnoses. As Figure A1 suggests, the rates based on one diagnosis are almost identical across the two data sources for the different age groups and data years, suggesting that even though we only observe children if they visited a doctor at least once in our data our approach does not vastly overestimate ADHD prevalence in Germany.

Figure A1 ADHD Prevalence in Germany – Baseline and Comparison Data

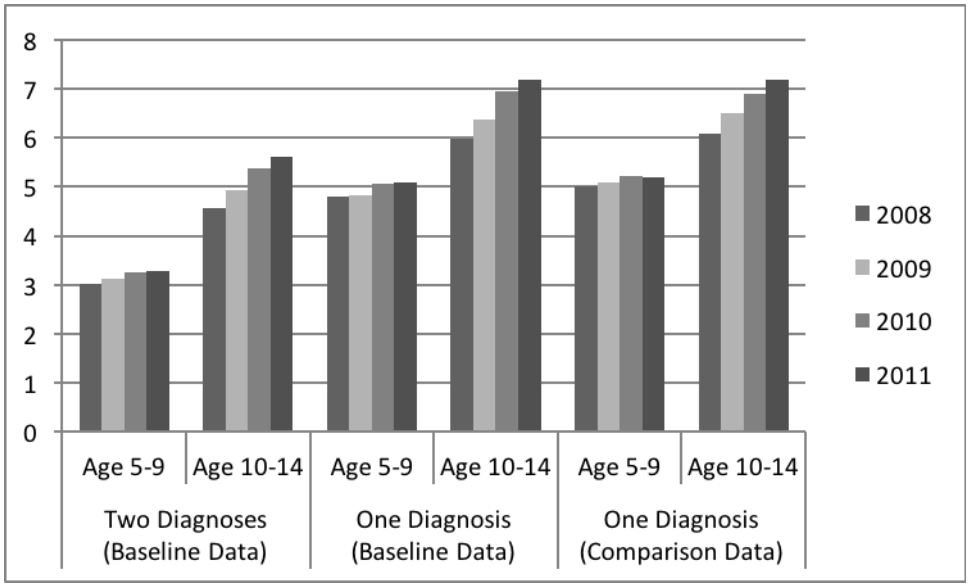
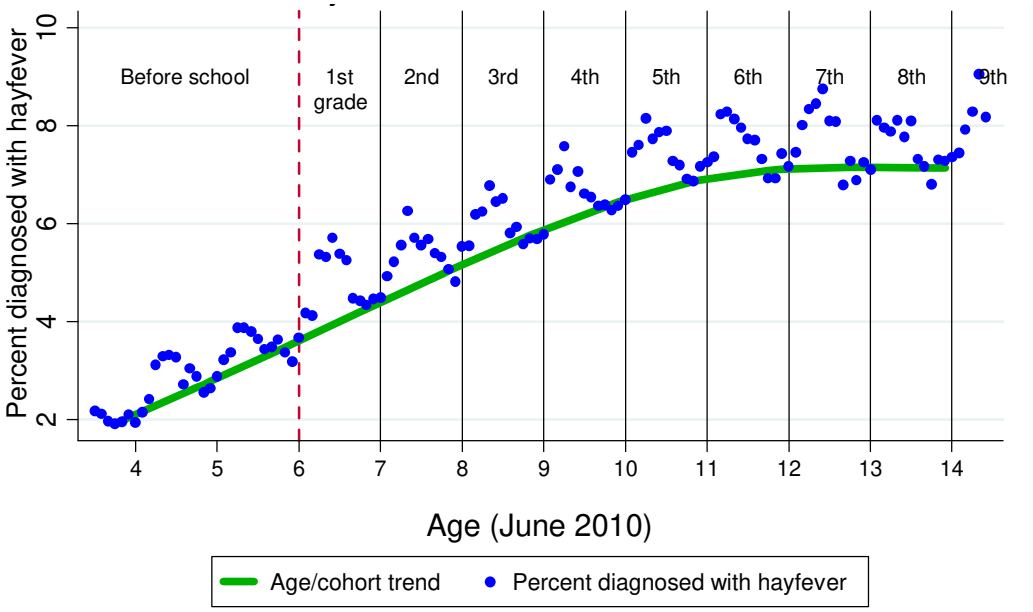
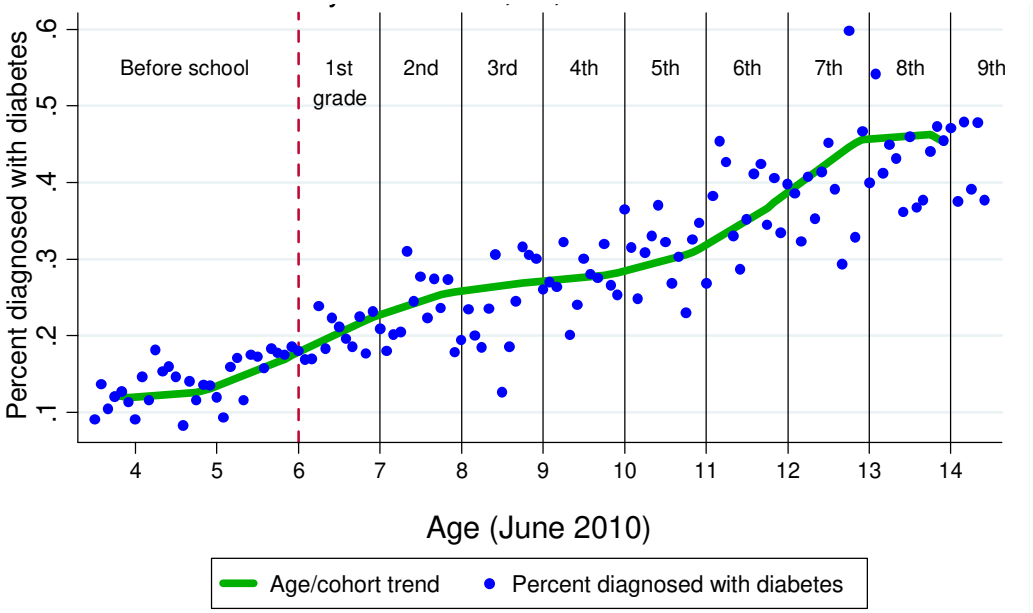


Figure A2: Hay fever prevalence across age, in states with June 30 as school entry cutoff date.



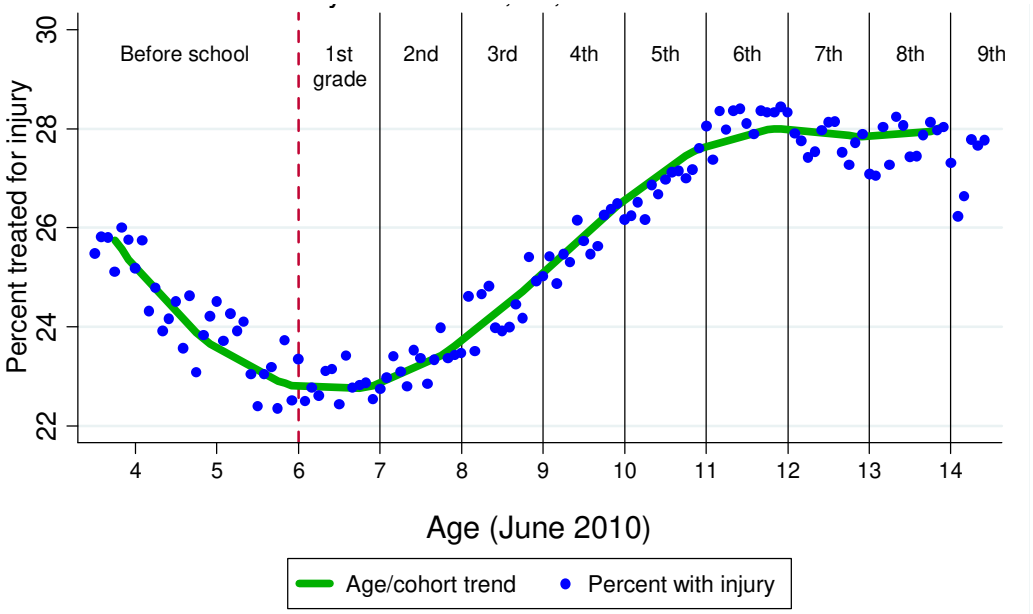
Notes: This figure shows the percent of children diagnosed with Hay fever in 2010 by children's age, measured in months as of June 2010. The sample includes all states with June 30 as school entry cutoff and without reforms in the cutoff dates. N=1,685,730. Average prevalence is 5.81%. The dashed line indicates the imputed school start (i.e. those who are of age 6 or above in June 2010 are supposed to enter school). The solid lines show the respective imputed cutoffs between grades at higher ages.

Figure A3: Diabetes prevalence across age, in states with June 30 as school entry cutoff date.



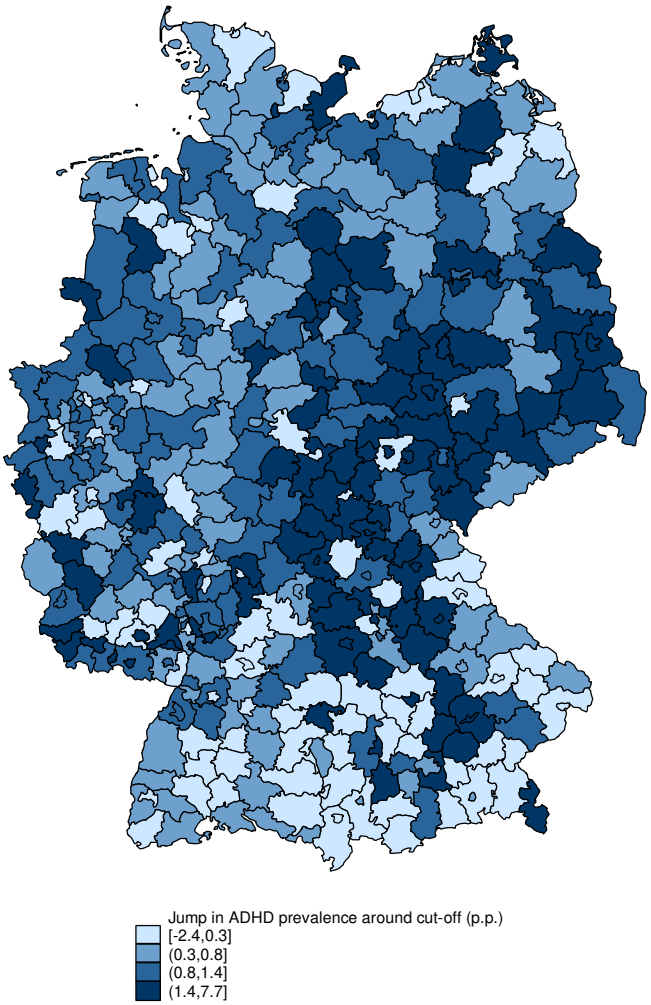
Notes: This figure shows the percent of children diagnosed with diabetes in 2010 by children's age, measured in months as of June 2010. The sample includes all states with June 30 as school entry cutoff and without reforms in the cutoff dates. N=1,685,730. Average prevalence is 0.3%. The dashed line indicates the imputed school start (i.e. those who are of age 6 or above in June 2010 are supposed to enter school). The solid lines show the respective imputed cutoffs between grades at higher ages.

Figure A4: Percent of children treated for injuries, among those without ADHD diagnosis



Notes: This figure shows the percent of children without ADHD diagnosis treated for injuries in 2010 by children's age, measured in months as of June 2010. The sample includes all states with June 30 as school entry cutoff and without reforms in the cutoff. N=1,626,712. Average prevalence is 25.5%. The dashed line indicates the imputed school start (i.e. those who are of age 6 or above in June 2010 are supposed to enter school). The solid lines show the respective imputed cutoffs between grades at higher ages.

Figure A5: Average jumps in ADHD prevalence around cutoff (pooled 2008-2011)



Notes: Pooling (within grade) jumps across imputed grades 3-8. Due to timing of reforms, included grade levels vary for states with cutoff date reforms.

Appendix Table 1: Cutoff Dates Across States and Years

	Until 2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
States without Reform of Cutoff Date										
Bremen	June 30	…	…	…	…	…	…	…	…	June 30
Hamburg	June 30	…	…	…	…	…	…	…	…	June 30
Hesse	June 30	…	…	…	…	…	…	…	…	June 30
Mecklenburg West-Pommerania	June 30	…	…	…	…	…	…	…	…	June 30
Saarland	June 30	…	…	…	…	…	…	…	…	June 30
Saxony	June 30	…	…	…	…	…	…	…	…	June 30
Saxony -Anhalt	June 30	…	…	…	…	…	…	…	…	June 30
Schleswig-Holstein	June 30	…	…	…	…	…	…	…	…	June 30
States with reform of Cutoff Date										
Baden-Wuerttemberg	June 30	…	…	July 31	Aug 31	Sep 30	…	…	…	Sep 30
Bavaria	June 30	…	…	July 31	Aug 31	Sep 30	Oct 31	Nov 30	Sep 30	Sep 30
Berlin	June 30	…	…	Dec 31	…	…	…	…	…	Dec 31
Brandenburg	June 30	…	…	Sep 30	…	…	…	…	…	Sep 30
Lower Saxony	June 30	…	…	…	…	…	…	…	July 31	Aug 31
North-Rhein Westphalia	June 30	…	…	…	…	July 31	…	Aug 31	…	Sep 30
Rhineland-Palatinate	June 30	…	…	…	…	…	Aug 31	…	…	Aug 31
Thuringia	June 30	July 31	…	…	…	…	…	…	…	July 31

Notes: … indicates no change in cutoff date.

Appendix Table 2: Additional Data Sources

Variable	Geo. Level	Data Source
Supply of Physicians		
Pediatricians/100,000 inhabitants	District level	INKAR[a]
General Practitioners/100,000 inhabitants	District level	INKAR
Psychotherapists/100,000 inhabitants	District level	INKAR
Psychologists/100,000 inhabitants	District level	INKAR
Physicians/100,000 inhabitants	District level	INKAR
Socio-Economic Background		
Share employees with higher education (%)	District level	INKAR
Unemployment rate (%)	District level	INKAR
Share foreigners (%)	District level	INKAR
School Environment		
Average class size (students/class)	District level	Statistical services of the different German states
Share foreign students in schools (%)	District level	INKAR
Compliance rate with cutoff dates (%)	State level	German Federal Statistical Office, Fachserie 11, Reihe 1

Notes: ([a])INKAR (Indikatoren und Karten zur Raum- und Stadtentwicklung) is a service provided by the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) (see www.inkar.de).

Appendix Table 3: ADHD by birth months – cohort size as denominator

	June 30 (1)	**July 31** (2)	**Sept 30** (3)	**Dec 31** (4)
Month of Birth – Ref Jan				
Feb	0.001	0.001	0.003	0.004*
	(0.001)	(0.003)	(0.005)	(0.002)
Mar	0.003***	0.002	0.005	0.003
	(0.001)	(0.003)	(0.005)	(0.002)
Apr	0.004***	0.006*	0.005	-0.000
	(0.001)	(0.003)	(0.005)	(0.002)
May	0.004***	0.007**	0.008	0.004*
	(0.001)	(0.003)	(0.005)	(0.002)
Jun	**0.005*** **	0.004	0.009*	0.008***
	(0.001)	(0.003)	(0.005)	(0.002)
Jul	**-0.004*** **	**0.006** **	0.006	0.009***
	(0.001)	(0.003)	(0.005)	(0.002)
Aug	-0.003***	**-0.005**	0.008	0.007***
	(0.001)	(0.003)	(0.005)	(0.002)
Sep	-0.004***	-0.007**	**0.002**	0.006***
	(0.001)	(0.003)	(0.005)	(0.002)
Oct	-0.002**	-0.006**	**-0.001**	0.010***
	(0.001)	(0.003)	(0.005)	(0.002)
Nov	-0.000	-0.002	-0.003	0.008***
	(0.001)	(0.003)	(0.005)	(0.002)
Dec	0.001	0.002	0.001	**0.011*** **
	(0.001)	(0.003)	(0.005)	(0.002)
ADHD prev (%)	4.02	5.62	4.77	4.21
p-value (June=July)	<0.0001	0.534	0.509	0.686
p-value (diff between months around cutoff)	<0.0001	0.0003	0.575	<0.0001

** p <0.1 ** p < 0.05 *** p<0.01*

Notes: Robustness analysis to Table 3: using entire cohort in state as denominator instead of children who appear in the claims data. Coefficients and standard errors after OLS estimation. Pooling all data years (2008-2011) and cohorts in imputed grade levels 3 to 8. Cohorts who are directly affected by shifts in cutoffs (and are thus larger than normal cohorts) excluded. p-values in last two line for two hypotheses tests: equality between June and July coefficients and between coefficients around cutoff date in respective column. Coefficients for birth months around relevant cutoff in bold.

Appendix Table 4: Share in data by month of birth for all kids and kids without ADHD

	June 30		July 31		Sept 30		Dec 31	
	All kids	No ADHD	All kids	No ADHD	All kids	No ADHD	All kids	No ADHD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Month of Birth – Ref Jan.								
Feb	-0.002	-0.003	0.005	0.004	-0.004	-0.007	-0.002	-0.005
	(0.004)	(0.004)	(0.006)	(0.007)	(0.022)	(0.018)	(0.010)	(0.010)
Mar	0.002	-0.002	-0.008	-0.011	-0.007	-0.012	0.013	0.010
	(0.004)	(0.004)	(0.006)	(0.007)	(0.022)	(0.018)	(0.009)	(0.010)
Apr	-0.001	-0.005	-0.001	-0.007	-0.007	-0.012	-0.001	-0.000
	(0.004)	(0.004)	(0.006)	(0.007)	(0.022)	(0.018)	(0.010)	(0.010)
May	-0.000	-0.005	0.001	-0.006	-0.007	-0.015	0.010	0.006
	(0.004)	(0.004)	(0.006)	(0.007)	(0.022)	(0.018)	(0.009)	(0.010)
Jun	0.002	-0.003	0.004	0.000	-0.005	-0.014	0.012	0.004
	(0.004)	(0.004)	(0.006)	(0.007)	(0.022)	(0.018)	(0.009)	(0.010)
Jul	-0.007*	-0.003	0.002	-0.004	-0.013	-0.019	0.030***	0.022**
	(0.004)	(0.004)	(0.006)	(0.007)	(0.021)	(0.017)	(0.009)	(0.010)
Aug	-0.004	-0.001	-0.001	0.004	-0.002	-0.010	0.010	0.003
	(0.004)	(0.004)	(0.006)	(0.007)	(0.021)	(0.018)	(0.009)	(0.010)
Sep	-0.004	0.000	-0.005	0.002	-0.005	-0.007	0.017*	0.011
	(0.004)	(0.004)	(0.006)	(0.007)	(0.021)	(0.018)	(0.009)	(0.010)
Oct	-0.005	-0.003	-0.005	0.001	-0.003	-0.003	0.026***	0.016
	(0.004)	(0.004)	(0.006)	(0.007)	(0.022)	(0.018)	(0.009)	(0.010)
Nov	0.001	0.001	0.006	0.007	0.006	0.009	0.029***	0.021**
	(0.004)	(0.004)	(0.006)	(0.007)	(0.022)	(0.018)	(0.010)	(0.010)
Dec	0.007	0.006	0.003	0.002	-0.009	-0.010	0.029***	0.018*
	(0.004)	(0.004)	(0.006)	(0.007)	(0.022)	(0.018)	(0.009)	(0.010)
N birth cohort	4,278,818	4,278,818	635,980	635,980	477,091	477,091	290,977	290,977
Share in data	0.86	0.82	0.88	0.82	0.88	0.83	0.80	0.76
p-value (June=July)	0.029	0.964	0.724	0.568	0.693	0.764	0.054	0.093
p-value (diff between months around cutoff)	0.029	0.964	0.515	0.250	0.941	0.809	0.003	0.090

** p <0.1 ** p < 0.05 *** p<0.01*

Notes: Dep var (odd columns): Share of children in birth cohort covered in medical claims, (even columns): Share of children in birth cohort in medical claims but without ADHD diagnosis. Coefficients and standard errors after OLS estimation. Pooling all data years (2008-2011) and cohorts in imputed grade levels 3 to 8. Cohorts who are directly affected by shifts in cutoffs (and are thus larger than normal cohorts) excluded. p-values in last two line for two hypotheses tests: equality between June and July coefficients and between coefficients around cutoff date in respective column.

Appendix Table 5: Explaining jumps measured between imputed grades 3-8

Dep. var.: Change in ADHD prevalence around age cutoff (in p.p.)	(1)	(2)	(3)	(4)	(5)
Physicians (per 100,000 inhabitants)					
Pediatricians	-0.048	-0.085+	-0.031	-0.054	0.015
	(0.051)	(0.057)	(0.140)	(0.138)	(0.208)
Primary care physicians	-0.020	-0.003	-0.069*	-0.076*	-0.115+
	(0.016)	(0.015)	(0.040)	(0.042)	(0.072)
Psychiatrists	-0.053	-0.090+	-0.039	-0.076	-0.235+
	(0.037)	(0.055)	(0.102)	(0.104)	(0.155)
Psychologists	-0.019**	-0.026**	-0.034	-0.038	-0.074+
	(0.008)	(0.010)	(0.043)	(0.046)	(0.049)
Schools					
Share foreign students (%)	0.127***	0.120***	0.262**	0.268**	0.297**
	(0.047)	(0.045)	(0.125)	(0.125)	(0.128)
Class size				0.274+	0.386*
				(0.173)	(0.196)
Parental Background					
Share employees with higher education (%)	0.008	0.031	0.534**	0.455**	0.294
	(0.039)	(0.053)	(0.218)	(0.222)	(0.267)
Unemployment rate (%)	-0.024	-0.088*	0.064	0.082	0.069
	(0.030)	(0.046)	(0.091)	(0.089)	(0.114)
Log labor income	0.841	0.742	8.651**	7.917**	8.472
	(0.917)	(1.479)	(3.964)	(3.868)	(6.128)
Controls	Yes	Yes	Yes	Yes	Yes
State F.E.	No	Yes	-	-	-
Distr. F.E.	No	No	Yes	Yes	-
Difference Specification (2011-2008)	No	No	No	No	Yes
R2	0.222	0.287	0.730	0.730	0.206
N (district x year)	380	380	380	376	94

** p <0.1 ** p < 0.05 *** p<0.01*

Notes: Included cohorts: Children born in quarters before and after the cutoff dates between grades 3/4, 4/5, 5/6, 6/7 and 7/8 in data years 2008-2011. Only children in states without reforms in cutoff dates included. Dep var (columns 1-4)=cutoff jump in p.p. in years 2008-2011. Column (5): Dep var and controls measured as changes between 2011-2008. Standard Errors clustered at district level in parentheses. All specifications include year fixed effects. Controls include district-level share of foreigners, physicians per 100,000 inhabitants, dummies for urban districts, for East Germany, and the state-level compliance rate. The sample excludes states that had cutoff date reforms. In columns (4) and (5) one district (Hamburg) is excluded because information on class size is not available for this district. District level variables stem mainly from the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) (see Appendix Table 2).

Appendix Table 6: ADHD prevalence and district level characteristics

Dep. var.: ADHD prevalence (in p.p.)	(1)	(2)	(3)	(4)	(5)	(6)
Physicians (per 100,000 inhabitants)						
Pediatricians	0.052	-0.054	-0.143	0.024	0.018	0.026
	(0.106)	(0.091)	(0.106)	(0.072)	(0.074)	(0.115)
Primary care physicians	-0.038	-0.057*	-0.043	-0.031	-0.032	-0.071*
	(0.033)	(0.030)	(0.033)	(0.024)	(0.024)	(0.039)
Psychiatrists	-0.028	-0.059	-0.091	-0.029	-0.036	-0.172
	(0.065)	(0.075)	(0.098)	(0.063)	(0.064)	(0.122)
Psychologists	-0.070***	-0.019	-0.034	-0.004	-0.007	-0.038
	(0.019)	(0.018)	(0.021)	(0.023)	(0.025)	(0.039)
Schools						
Share foreign students (%)		0.152	0.137	-0.000	0.001	0.004
		(0.095)	(0.096)	(0.053)	(0.054)	(0.067)
Class size					0.061	0.137
					(0.094)	(0.109)
Parental Background						
Share employees with higher education (%)		0.065	0.109	-0.218*	-0.231**	-0.335*
		(0.074)	(0.074)	(0.110)	(0.112)	(0.188)
Unemployment rate (%)		0.029	0.004	0.059	0.064	0.103
		(0.064)	(0.112)	(0.056)	(0.055)	(0.074)
Log labor income		3.321*	3.129	3.441	3.422	6.091
		(1.875)	(2.144)	(3.127)	(3.163)	(5.015)
Controls	No	Yes	Yes	Yes	Yes	Yes
State F.E.	No	No	Yes	-	-	-
Distr. F.E.	No	No	No	Yes	Yes	-
Difference Specification (2011-2008)	No	No	No	No	No	Yes
R2	0.254	0.442	0.545	0.975	0.975	0.175
N (district x years)	380	380	380	380	376	94

** p <0.1 ** p < 0.05 *** p<0.01*

Notes: Dep var=ADHD prevalence (in imputed grades 3-8) in p.p. in years 2008-2011. Standard Errors clustered at district level in parentheses. All specifications include year fixed effects. Controls include district-level share of foreigners, unemployment rate, physicians per 100,000 inhabitants. In columns (4) one district (Hamburg) is excluded because information on class size is not available for this district. District level variables stem mainly from the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) (see Appendix Table 2).